Evolution of vascular fellowship training in the new era of endovascular techniques

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Purpose: **The endovascular technique has revolutionized the treatment of infrarenal abdominal aortic aneurysm (AAA). At our institution, we examined the impact of an endovascular program on the traditional operative training of the vascular fellows in the treatment of infrarenal AAA.**

Methods: **We examined the records of our vascular fellows' experience from July 1995 to May 2000. We introduced the endovascular treatment for infrarenal AAA in 1995.**

Results: **The fellows have performed increasing numbers of endovascular cases each year, with a predicted number of 124 cases for 1999-2000. However, despite an increase in the overall volume of patients with infrarenal AAA (102 cases in 1998-1999 and a predicted 160 cases in 1999-2000), the trainees will experience a reduction in the number of open AAAs from 61 cases in 1998-1999 to a predicted 36 cases in 1999-2000. However, the volume of open suprarenal AAA has also increased from eight cases in 1998 to 1999 to a predicted 24 cases in 1999-2000. With no significant change in the open aortoiliac occlusive cases from previous years, the current fellows will graduate with a similar volume of open aortic procedures as their predecessors.**

Conclusion: **With the recent advances in endovascular technology, our traditional operative approach to the treatment of AAA disease may be lacking in the training of future vascular surgeons. At our institution, although fewer open infrarenal AAA cases were performed, the trainees have maintained the open aortic experience by performing an increased volume of suprarenal AAAs. We have to critically reevaluate and redefine what constitutes adequate vascular fellow experience in the surgical treatment of abdominal aortic aneurysms. (J Vasc Surg 2001;33:S106-10.)**

The endovascular technique has revolutionized the elective treatment of infrarenal abdominal aortic aneurysm (AAA) in recent years. As such, traditional open treatment of infrarenal AAA might become scarce in institutions in which the endovascular technique is available. This change in the practice of vascular surgery has had a great impact at all levels, but perhaps none greater than in the training of future vascular surgeons. Recent publications have addressed the issue of training and credentialing in the endovascular techniques, but the literature is void of the subject of training and credentialing of open treatment of AAA. In fact, because most infrarenal AAAs are treated with endovascular devices, vascular surgeons will be faced with more complex AAA (such as juxtarenal or coexisting iliac aneurysm) in the operative field rather than the routine infrarenal aortic disease. Although this shift in the operative spectrum may mean little to an established open vascular surgeon, the issue of competence in open technique must be revisited when addressing the future generation of vascular surgeons. After all, a number of studies have suggested that the risk of elective open aneurysm repair is directly influenced by the case volume of the responsible surgeons.[1-3]

Zarins and colleagues[4] recently reported that the volume of open AAAs has remained the same despite a significant increase in the number of endovascular cases. However, they have not addressed the issue of vascular fellowship training. To determine the impact of the endovascular program on the vascular fellows' experience with open treatment of AAA, we examined the experience of the fellowship trainees in the past 5 years, starting in 1995 when the endovascular device was first introduced to Barnes-Jewish Hospital. We also examined its impact on the general surgery program.

METHODS

The records of vascular fellow case experience from July 1995 to May 2000 in the Section of Vascular Surgery at Barnes-Jewish Hospital/Washington University Medical Center were obtained. The fellows' experience for the academic year 1999-2000 is extrapolated from the volume of procedures performed from July 1, 1999, to May 31, 2000, for comparison purposes. During the 5-year period, we had two clinical fellows each academic year. Open treatment for infrarenal AAA is defined as the replacement of the aneurysmal aorta below the renal arteries, regardless of the level of intraoperative aortic clamping. Open treatment of suprarenal AAA is defined as the replacement of the

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Table I. Combined fellowship trainee experience with elective infrarenal AAA repair by academic year

Academic year	*Open repair (n)*	*Endovascular repair (n)*
1995-96	43	2
1996-97	54	7
1997-98	43	32
1998-99	61	41
1999-2000*	36	124

*Predicted 1-year total based on 11-month data.

aneurysmal aorta that involves the renal arteries or above (eg, juxtarenal, suprarenal AAA, thoracoabdominal AA [TAAA], or thoracic aortic aneurysm). Endovascular treatment for infrarenal AAA is defined as the exclusion of the aneurysmal aorta below the renal arteries with a covered stent graft (eg, Ancure, Guidant EVT, Menlo, Calif; Excluder, W.L. Gore, Flagstaff, Arix; AneuRx, Medtronic AVE, Santa Rosa, Calif; Talent, World Medical Manufacturing Corp, Sunrise, Fla, and homemade covered stents) introduced through a common femoral or a external iliac artery.

The records of chief resident case experience at all the hospitals that participate in their training were obtained. The chief resident experience for the entire general surgery residency is extrapolated from the vascular procedures performed from internship to May 31, 2000, for comparison purposes. The vascular service at Barnes-Jewish Hospital is divided into three separate subservices, led by two fellows and a chief resident in a rotating fashion from month to month. The vascular fellows do not rotate in any other hospital.

Differences between groups were analyzed by chi-squared analysis or by analysis of variance as indicated. Probability values less than .05 were considered significant.

RESULTS

Vascular fellow experience. The vascular fellows at our institution have performed an increasing number of endovascular AAA cases each year, with a predicted combined number of 124 cases for the year 1999-2000 (Table I). However, despite an increase in the overall volume of patients with infrarenal AAA (120 cases in 1998-1999 and a predicted 160 cases in 1999-2000), the trainees will experience a reduction in the number of open AAAs from 61 cases in the 1998-1999 to a predicted 36 cases in the year 1999-2000 ($P < .001$; chi-squared). Although the overall number (open and endovascular) of infrarenal AAA experience places our current fellows above the 90th percentile (vascular fellowship 1997-98 Accreditation Council for Graduate Medical Education program national data), the predicted number of open cases in the current fellows' experience will fall to the 30th percentile.

Table II. Percentage of elective infrarenal AAA repair that required suprarenal or supraceliac aortic clamping

Academic year	*Open repair (n)*	*Suprarenal aortic clamping (n; %)*
1997-98	43	9 (21)
1998-99	61	16 (28)
1999-2000*	36	10 (30)

*Predicted 1-year total based on 11-month data.

Table III. Combined fellowship trainee experience with elective suprarenal AAA repairs by academic year

Academic year	*Open repair (n)*	*Endovascular repair (n)*
1997-98	4	0
1998-99	8	0
1999-2000*	24	4

*Predicted 1-year total based on 11-month data.

Since the advent of endovascular treatment of infrarenal AAA, the complexity of routine open infrarenal AAA repair has increased. The trend has continued, even after the establishment of the endovascular treatment in our institution. The percentage of infrarenal AAA repair that requires suprarenal or supraceliac aortic clamping has steadily increased from 21% in 1997-1998 to a predicted 30% in 1999-2000 (Table II).

In addition to the increase in the complexity of the open infrarenal AAA, there has been an increase in the volume of elective suprarenal AAAs (eg, suprarenal AAA, TAAA, and thoracic aortic aneurysm). The fellows' experience has grown steadily from a combined four open repairs in year 1997-1998 to a predicted 24 open repairs, with a predicted four endovascular repairs of thoracic aneurysm (Table III).

The vascular fellows' increased exposure to endovascular treatment is not limited to the treatment of infrarenal AAA. We have also noted additional exposure to iliac angioplasty and stenting with covered and noncovered stents in both the operating room and radiology angiosuites. However, there was no significant change in the experience of aortic surgeries for aortoiliac occlusive disease in the course of the last 3 years (Table IV). In fact, when the total open aortic cases are tallied, there has not been a significant change. In addition, there was no significant difference in the number of other open aortic cases (including mesenteric and renal arteries and ruptured aortic aneurysms) between the current fellows and the previous fellows (data not shown).

General surgery resident vascular experience. We looked at the effect that endovascular technique had on the training of general surgery residents. Despite no sig-

Table IV. Combined fellowship trainee experience with elective open aortic repair by academic year

Academic year	*Aneurysm repair (n)*	*Occlusive repair (n)*	*TOTAL (n)*
1997-98	47	24	71
1998-99	69	28	97
1999-2000*	60	27	87

*Predicted 1-year total based on 11-month data.

Table V. Combined general surgery resident experience (6 or 7 chiefs) with elective open infrarenal AAA repair

Graduating class	*Total (n)*	*On vascular service (n)*	*Vascular cases per resident (n)*
1996-97	36	26	117
1997-98	46	29	79
1998-99	33	17	86
1999-2000*	21	13	96

*Predicted 1-year total based on 11-month data.

nificant change in the total number of major vascular cases, there has also been a steady decrease in the open infrarenal AAA repairs performed by the general surgery residents (Table V). Most of the vascular experience comes from the Veterans Administration (VA) Hospital rotation and the vascular service rotation. Since the Food and Drug Administration approval of two stent-graft devices (Ancure and AneuRx) in the treatment of infrarenal AAA, all eligible VA patients received the endovascular treatment at the Barnes-Jewish Hospital.

DISCUSSION

The future of vascular fellowship training is in flux. Endovascular intervention and issues of training and credentialing in endovascular technique have monopolized the discussions on the future of vascular surgery and surgical education. In the treatment of infrarenal AAA, its impact is most profound. In many fellowship training centers, endovascular treatment has replaced the traditional open repair as the first line of therapy for infrarenal AAA. In our own program, the two clinical fellows have experienced a steady rise in the number of endovascular intervention for infrarenal AAA, with the predicted sum of 124 cases for the academic year 1999-2000, while having experienced a steady decline in the number of open cases (predicted sum of 36 cases for the year; Table I). Hence, 74% of infrarenal AAAs that are encountered by the current fellowship trainees were treated with an endovascular device. The reasons for the greater use of endovascular devices are three-fold: (1) technology has produced better, smaller devices that can be applied to a wider spectrum of aortic anatomy; (2) surgeons are becoming acclimated with the use of endovascular devices and are pushing the limits of its application; and (3) patients are referred to our center specifically for the endovascular treatment. If the trend in the recent years is any indication, the percentage of endovascular cases will only increase in the future, barring any new information that inhibits its use.

Table VI. Poll of the surgical faculty of the University of California, San Francisco, regarding the minimum number of vascular reconstructive operations that need to be performed under supervision to acquire proficiency

Procedure	*Minimum operations (n)*
Cerebrovascular	
Carotid	10
Vertebral-subclavian	3
Innominate	2
Transcervical	2
Extremities	
Profunda femoris	4
Femoropopliteal	5
Axillofemoral	2
Femorofemoral	2
Embolectomy	5
Abdominal	
Visceral	2
Renal	2
Aortoiliac	20
Aneurysm	10
Occlusion	10
Miscellaneous	
Trauma	6
Portal-systemic shunts	3
Microvascular	6
TOTAL	74

Data from Moore WS, Treiman RL, Hertzer NR, et al. Guidelines for hospital privileges in vascular surgery. J Vasc Surg 1989;10:678-82.

We have also determined that the complexity of the open infrarenal AAA repair has changed in the recent years. We see a steady increase in the percentage of suprarenal aortic clamping needed in the open infrarenal AAA repair, to a high of 30% this year (Table II). This phenomenon is not unexpected because a short length of normal aorta between the renal arteries and the aneurysm is a contraindication for endovascular repair. As transrenal endovascular devices become commercially available, this percentage will only increase. Hence, our fellows are exposed to a shrinking number of open infrarenal AAA repairs and an increasing proportion of complex aortic anatomy. Because a number of studies have suggested that the risk of elective open aortic aneurysm repair is directly influenced by the case volume of the responsible surgeons,[1-3] on face value, our current fellows may be graduating with less preparation than the graduates of previous years.

Fortunately, we had a significant increase in the open repair of suprarenal AAA and TAAA (Table III). The currently predicted sum of 24 suprarenal cases is a three-fold increase from the previous year and a six-fold increase from 2 years prior. The reason for the sudden increase of

more complex aortic aneurysms is not immediately clear. Our institution has seen an increase in the complex infrarenal AAAs because these patients are referred to our service from outside institutions for an endovascular treatment evaluation. More often than not, the patients elect to have the open surgery at our institution although they are not candidates for endovascular therapy. As for the suprarenal aortic aneurysm, we believe that there are three reasons: (1) our institution is being identified as the regional aortic aneurysm center, and patients are referred to us directly, bypassing the regional vascular surgeon; (2) with the advent of minimally invasive repair of AAA and thoracic aneurysm, doctors are more willing to refer patients earlier and more readily with any diagnosis of aortic aneurysm, although they may be "borderline" candidates; and (3) with a greater awareness of minimally invasive treatment for aortic aneurysm, there is an increased surveillance for aortic aneurysm in smaller community hospitals and centers (eg, community centers, churches).

Moreover, the fellows' experience in aortic surgery for aortoiliac occlusive disease has not changed (Table IV) in the recent years, despite a significant increase in the fellows' experience with iliac stenting with covered and noncovered stent (data not shown). Although the experience of an open aortobifemoral bypass grafting is not the same as that of an open infrarenal AAA repair, the experience of infrarenal aortic dissection and aortic anastomosis is transferable to the traditional open AAA repair. The current fellows' total experience in aortic surgery has not significantly changed and is, in fact, higher than 2 years ago (Table IV). We have not included the cases that involve mesenteric and renal revascularizations or repair of ruptured aortic aneurysm.

At our institution, despite a significant decrease in the number of open infrarenal AAA repair procedures, the total number of aortic procedures has remained stable. In fact, our current fellows experience an overall increase in the complexity of the open aortic aneurysm repair, which may indeed be a better preparation for future vascular surgeons. For the fellowship training programs to properly prepare trainees for the competitive endovascular market and the complex open surgery market, training and credentialing in open techniques must not be a second priority to that of endovascular techniques. At the 27th Annual Meeting of the Society for Vascular Surgery in 1973, there was a panel discussion on the topic of vascular surgical training. The surgical faculty of the University of California, San Francisco, was polled regarding the minimum number of vascular reconstructive operations that needed to be performed under supervision to acquire proficiency[5] (Table V). This list was later adapted as the minimum of 70 major vascular cases required for graduates of a vascular surgery fellowship and suggested by the position paper of the Joint Vascular Surgery Societies for hospital privileging.[6] On the list, there are a minimum number of 10 cases of aortic aneurysms. Although this minimal number is not a measure of competence, it is a measuring stick with which to compare the changes in the vascular fellowship trainee experience at the national level. According to the vascular fellowship 1997-1998 Accreditation Council for Graduate Medical Education program national data, the average number of infrarenal AAAs and suprarenal AAAs are 22 and 4, respectively. These numbers have not changed significantly in the last several years. If the current trend toward endovascular repair of infrarenal AAAs continues at 74% or higher, the new national average of open infrarenal AAA repair will be five or six cases. That will make the national average for all open aortic aneurysm repairs to be nine or 10. Hence, more than 50% of all graduating vascular fellows will not meet the minimum recommendation. Furthermore, in the new era of more complicated open aortic repair, even a minimum number of 10 cases may not be enough to develop into a competent vascular surgeon. Interestingly, the volume of suprarenal AAA cases grew with the increasing number of endovascular AAA repairs at our institution. Introducing more suprarenal cases may be the only method a fellowship program has in combating the deficiencies created by the endovascular technology.

We also looked at the vascular experience of the general surgery residents at Barnes-Jewish Hospital to determine the effect of the endovascular program on their training. Despite no significant difference in the total volume of major vascular procedures, there has been a steady decline in the number of open infrarenal AAA repairs in the last 3 years (Table VI). The current general surgery residents will graduate with approximately three open aortic reconstructions for infrarenal AAA per resident. An average of two open repairs were performed on the vascular service as a chief resident, although the rest were performed on the VA Hospital rotation. These numbers bring two issues into light. First, in the era of complex open infrarenal AAA repair, these general surgery residents are underprepared to perform complex AAA repairs after graduation without further vascular training. Second, with the overall cases of open AAA repair spread so thinly already, simply shifting the open cases from the general surgery residents to the vascular fellows may not be enough to compensate for the loss in the overall volume of open cases for the vascular fellows.

A challenge of the vascular fellowship training programs is to produce competent endovascular and open procedure surgeons while avoiding residency review committee citations for negative impact on general surgery residents. In 1991, 40% of vascular surgery programs received

residency review committee citations for negative impact on general surgery residents; 26% of the programs were cited specifically for deficient operative experience for the residents.[7] Unless the vascular training for the general surgery residents is redefined, these citations will be seen more frequently in the future. The days of open aortic reconstruction after the completion of general surgery residency are over. As we embark on a new era of vascular surgery, we must focus on the task at hand by producing the expertise to meet the new challenges in a resourceful manner. Moreover, the fellowship programs must find alternative methods to train the future endovascular and open surgeons. If the adequate volume is not met, then the fellowship must be extended to two or more clinical years. We have to critically reevaluate and redefine what constitutes adequate vascular fellow experience, specifically in the open treatment of AAAs and generally in the expanding vascular surgical arena.

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